Claims

[c1]   What is claimed is:

A method for geosteering while drilling a formation, comprising:

generating a plurality of formation models for the formation, wherein each of the plurality of formation models includes a set of parameters and a deep reading logging-while-drilling resistivity tool therein, wherein locations of the deep reading logging-while-drilling resistivity tool differ in the plurality of formation models;

computing predicted tool responses for the deep reading logging-while-drilling resistivity tool in the plurality of formation models;

acquiring resistivity measurements using the deep reading logging-while-drilling resistivity tool in the formation;

determining an optimum formation model based on a comparison between an actual tool response and the predicted tool responses; and

steering a bottom hole assembly based on the optimum formation model.

[c2]   The method of claim 1, wherein the deep reading log-

ging-while-drilling resistivity tool is a deep reading induction tool.

[c3]   The method of claim 1, wherein the deep reading logging-while-drilling resistivity tool is a deep reading propagation tool.

[c4]   The method of claim 1, wherein the deep reading logging-while-driling tool comprises a first transmitter disposed about 11 meters from a receiver and a second transmitter disposed about 21 meters from the receiver.

[c5]   The method of claim 1, wherein the determining the optimum formation model comprises:
calculating a value of an error function at an error function grid in each of the plurality of formation models; and
finding a formation model that produces a minimum value of the error function.

[c6]   The method of claim 5, wherein the calculating the value of the error function is performed with constraints derived from other measurements.

[c7]   The method of claim 6, wherein the other measurements comprise at least one selected from the group consisting of measurements from a logging-while drilling gamma ray tool, measurements from a logging-while-drilling

shallow resistivity tool, data from seismic maps, measurements form logging-while-drilling nuclear magnetic resonance tool, and measurements made in a pilot hole.

[c8] The method of claim 5, further comprising using the value of the error function to provide an estimation of an error in determining a distance to a resistivity contrast.

[c9] The method of claim 5, wherein the error function is defined as a square root of a weighted sum of an average of squares of a difference between the predicted tool response and the actual tool response.

[c10] The method of claim 4, further comprising applying a minimization residual criterion to the plurality of formation models.

[c11] The method of claim 1, wherein the steering the bottom hole assembly comprises steering the bottom hole assembly to avoid a formation structure determined from the optimum formation model.

[c12] The method of claim 11, wherein the formation structure comprises one selected from the group consisting of a shale zone and a water zone.

[c13] The method of claim 1, wherein the steering the bottom hole assembly is performed to maintain a selected dis-

tance between the bottom hole assembly and a resistivity contrast determined from the optimum formation model.

[c14] The method of claim 13, wherein the resistivity contrast comprises a formation boundary.

[c15] The method of claim 1, wherein the acquiring the resistivity measurements is performed taken at a plurality of frequencies and at at least two different transmitter-receiver spacings.

[c16] The method of claim 1, further comprising normalizing the resistivity measurements to correct for sonde errors.

[c17] The method of claim 1, further comprising determining a distance between the bottom hole assembly and a formation boundary.

[c18] The method of claim 17, wherein the formation boundary is an oilwater contact.

[c19] The method of claim 18, further comprising correcting a true vertical depth estimate of the bottom hole assembly based on a known value of a depth of the oilwater contact and the distance between the bottom hole assembly and the oilwater contact.

[c20] The method of claim 1, further comprising determining a formation resistivity profile.

[c21] A method for geosteering, comprising:

obtaining an optimum formation model derived from data from a deep reading logging-while-drilling resistivity tool using an inversion technique; and

steering a bottom hole assembly to locate a well in a selected position with respect to formation boundaries.

[c22] The method of claim 21, wherein the steering the bottom hole assembly is performed to maintain a selected distance between the bottom hole assembly and a reservoir boundary determined from the optimum formation model.

[c23] The method of claim 21, wherein the steering the bottom hole assembly is performed to maintain the bottom hole assembly between two or more reservoir boundaries.

[c24] The method of claim 23, further comprising selecting a desired well location based on the optimum formation model, and wherein the steering the bottom hole assembly comprises steering the bottom home assembly so that the well is positioned in the desired well location.

[c25] A system for geosterring while drilling in a formation, comprising a computer having a processor and a memory, wherein the memory stores a program having in-

structions for:

generating a plurality of formation models for the formation, wherein each of the plurality of formation models includes a set of parameters and a deep reading logging-while-drilling resistivity tool therein, wherein locations of the deep reading logging-while-drilling resistivity tool differ in the plurality of formation models;

computing predicted tool responses for the deep reading logging-while-drilling resistivity tool in the plurality of formation models;

acquiring resistivity measurements using the deep reading logging-while-drilling resistivity tool in the formation;

determining an optimum formation model based on a comparison between an actual tool response and the predicted tool responses; and

selecting a steering solution for the bottom hole assembly.

[c26] The method of claim 25, further comprising normalizing the resistivity measurements to correct for sonde errors.

[c27] A system for geosteering while drilling in a formation, comprising a computer having a processor and a memory, wherein the memory stores a program having instructions for:

obtaining an optimum formation model derived from

data from a deep reading logging-while-drilling resistivity tool using an inversion technique; and

selecting a steering solution for a bottom hole assembly.

[c28]   A method for well characterization while drilling a formation, comprising:

generating a plurality of formation models for the formation, wherein each of the plurality of the formation model includes a set of parameters and a deep reading resistivity tool therein, wherein locations of the deep reading resistivity tool differ in the plurality of the formation models;

computing predicted tool responses for the resistivity tool in the plurality of formation models;

acquiring resistivity measurements using the deep reading resistivity tool in the formation; and

determining a formation resistivity profile.

[c29]   The method of claim 28, wherein the deep reading resistivity tool is a deep reading induction tool.

[c30]   The method of claim 28, wherein the resistivity tool is a deep reading propagation tool.

[c31]   The method of claim 28, wherein the deep reading resistivity tool comprises a first transmitter disposed about 11 meters from a receiver and a second transmitter dis-

posed about 21 meters from the receiver.

[c32]   The method of claim 28, further comprising normalizing the resistivity measurements to produce a tool independent response.

[c33]   The method of claim 28, wherein the resistivity profile exists in a transition zone in the formation.